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RECOMMISSIONING OF BENTONITE TEST EQUIPMENT

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December 1987

Project: 30.21.02
Beneficiation/Grinding Studies
of Selected Minerals

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14 pp

MINERAL SCIENCES LABORATORIES
Division Report MSL 87-153 (TR)

MICROMEDIA

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SUMMARY

Three bentonite samples were used to test existing instruments and previously established CANMET procedures for evaluating bentonite as drilling mud. The instruments tested were the Fann V-G meter and a Magcobar filter press. Bentonite properties measured included moisture, residue (sand content), colloidal content, swelling, viscosity and gel strength, and filtration. Only one bentonite sample, a high grade sodium bentonite met all the API specification requirements for oil-well drilling fluid materials.

Keywords: Bentonite, drilling mud, moisture, residue, colloidal content, swelling, viscosity, gel strength, filtration.

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NOUVELLE ÉTUDE PORTANT SUR UN APPAREILLAGE D'ESSAI POUR LE CONTRÔLE DE LA BENTONITE

par

S.S.B. Wang* et P.J.H. Prud'homme**

RÉSUMÉ

Nous avons utilisé trois échantillons de bentonite pour vérifier les instruments existants et les méthodes précédemment établies par CANMET pour évaluer la bentonite en tant que boue de forage. Le compteur Fann V-G et un filtre-presse Magcober ont été calibrés. Les propriétés de la bentonite qui ont été mesurées incluaient l'humidité, les résidus (contenu en sable), le contenu colloïdal, le gonflement, la viscosité et la résistance de gel, et la filtration. Un seul échantillon de bentonite, consistant en une bentonite à haute teneur en sodium, était conforme aux exigences stipulées par API concernant les matériaux fluides utilisés pour le forage des puits d'huile.

Mots-clé : bentonite (f), boue de forage, humidité, résidu, contenu colloïdal, gonflement, viscosité, résistance de gel, filtration.

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INTRODUCTION

As part of a larger program on industrial minerals and related research in Canada, CANMET has undertaken a review of past research on domestic deposits of bentonite. Equipment for evaluating bentonite as drilling mud was assembled and operating procedures checked and evaluated using bentonites obtained from an Ontario distributor in preparation for future in-house study and cost recovery work on Canadian bentonites[1]. The equipment and test procedures are described in detail below.

EVALUATION PROCEDURE

Sample Preparation

1. Crush the bentonite sample to about 6 to 12 mm, keeping a portion of 300 g for moisture and residue (sand content) determination.

2. Dry the crushed sample to a constant weight in an oven at a temperature of 100 to 105°C.

3. Dry-grind the dried bentonite to 80% minus 74 μm (200 mesh) and keep it in an air-tight container.

Moisture Measurement

1. Weigh 10 g of the crushed material to $\pm$ 0.01 g.
2. Dry to a constant weight at a temperature of 100°C.
3. Cool the sample in a desiccator and weigh it.

$$\% \text{ moisture} = \frac{\text{Wt original sample} - \text{Wt dry sample}}{\text{Wt original sample}} \times 100$$

The American petroleum Institute (API) specification specifies that moisture should be no more than 10%[2].

Residue (Sand Content) Determination

1. Add 100 g of crushed, dried bentonite to 1 L of distilled water.
2. Stir 10 min with a high-speed mixer.
3. Let stand for 2 h.
4. Stir the mixture for 5 min.
5. Wet-screen on a 200 mesh sieve.
6. Dry and weigh the oversize.

$$\% \text{ Residue (sand content)} = \frac{\text{wt residue}}{\text{wt sample}} \times 100$$

Maximum 2.5% residue is allowed in API specification.

Colloidal Content

1. Mix 10 g of ground bentonite for 20 min with 500 mL of distilled water in a high-speed mixer.
2. Pour the mixture into a graduated cylinder and allow to settle for 24 hrs.
3. Decant the liquid. Dry and weigh the residue.

$$\% \text{ Colloidal} = \frac{\text{Wt sample} - \text{Wt residue}}{\text{Wt sample}} \times 100$$

This test is a simple method for indicating the relative proportion of sodium bentonite in a sample.

Swelling

1. Add 2 g of ground bentonite, in 0.1 g lots, to a 100 mL graduated cylinder filled with distilled water, each addition being made after the previous one has settled.

2. Record the volume of gel one hour after the last addition.

Only sodium-based bentonite in water forms colloidal gels and swells. A moderately swelling bentonite will produce 15 to 20 mL of gel, a good variety about 25 mL, and an excellent grade about 30 mL or more.

Viscosity and Gel Strength

Viscosity and gel strength are measured by a direct-indicating viscometer, the Fann V-G meter laboratory model shown in Fig. 1. This is a rotational viscometer powered by a two-speed, 110-volt, synchronous motor. Mud is contained in the annular space (about 1.1 mm) between the two cylinders. The outer cylinder, or rotor sleeve, rotates at a constant speed. By changing gears and switching motor speed, six different rotational speeds are possible. The rotation in the mud produces a torque on the inner cylinder or bob. A dial attached to the bob indicates the displacement of the bob.

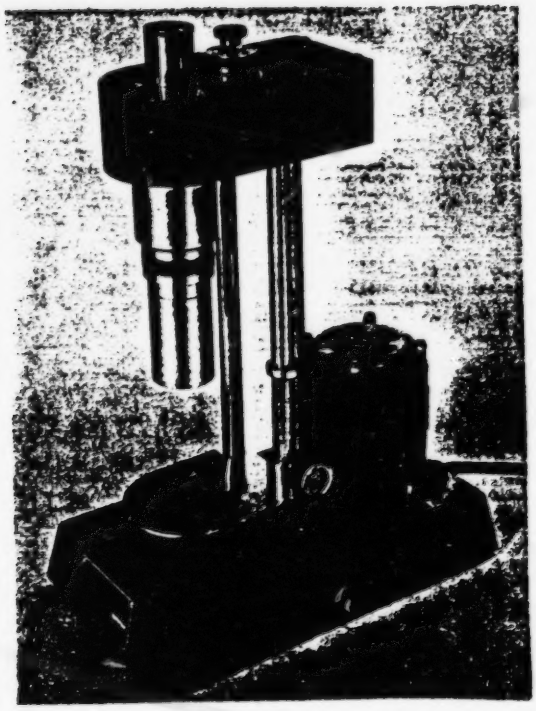

Fig. 1. - Fann V.G. meter - laboratory model

Operating Procedure:

1. Add 24 g of dried, ground bentonite and 376 mL of distilled water (6 Wt % bentonite) to a high speed mixer; mix for 10 min.

2. Store the sample in a sealed container for 24 h.

3. Stir the mud for 5 min. on mixer.

4. Pour the mud into the Fann testing cup to the marked level. Place the cup on the movable work table and adjust the mud surface to the scribed line on the rotor sleeve.

5. Place the motor speed switch in the high speed position and the gear shift knob in the down position. Start the motor; wait for indicator dial to come to steady value; and record the 600 rpm dial reading.

6. Change speed switch to "low" and obtain 300 rpm reading in the same manner as in step 5.

7. Stir sample thoroughly at 600 rpm. Lift gear shift to centre. Turn off motor and wait for 10 s.

8. Flip switch to "low" and record maximum deflection (at the instant of gel break) as initial gel strength (10 s gel).

9. Restir the mud at 600 rpm for 10 s. Let it stand for 10 min. Set the speed at 3 rpm and read the 10 minute gel strength.

10. Calculate the plastic viscosity (pV), the yield point (YP) and the apparent viscosity (AV).

$$PV = 600 \text{ rpm reading} - 300 \text{ rpm reading}$$

$$YP = 300 \text{ rpm reading} - PV$$

$$AV = \frac{600 \text{ rpm reading}}{2}$$

A good grade bentonite should have an apparent viscosity 15 cp (centipoise) or more. The API specification requires minimum plastic viscosity 8.0 cp.

Filtration

The filtration or wall-cake-building property of a mud is determined by using the Magcobar filter press shown in Fig. 2.

The A.P.I. filter loss is measured at surface temperature and 100 PSI and is reported as the number of mL fluid lost in 30 min.

The filter press consists of a mud cell assembly, a pressure regulator and gauge. The cell is connected to the regulator by a coupling adapter. The cell is closed by placing a lid firmly against a piece of filter paper and turning to the right until tight to force the filter paper against a neoprene O-ring fitted in the base of the cell. Pressure is supplied by a small cartridge of CO_2 gas.

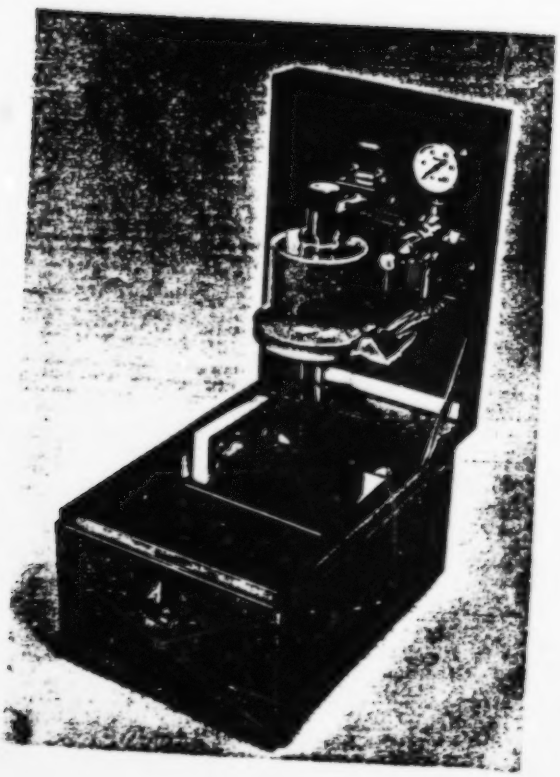

Fig. 2. - Macobar filter press

Operating procedure:

1. Open the cell by turning the lid at the bottom of the cell ¼ turn to the left. Make sure the lid is clean and the o-ring in good condition to provide sealing.

2. Fill the cell with mud sample from viscosity measurements to within 6 mm (¼ in) of O-ring groove. Place O-ring in groove and filter paper on top of O-ring; close the cell with the lid.

3. Connect the cell to the regulator. Turn ¼ turn in either direction to engage.

4. Place a 50 mL graduated cylinder under the filtrate opening.

5. Close the valve by turning it clockwise, with regulator screw backed out until no pressure is showing on the diaphragm. Insert gas cartridge holder and tighten until the cartridge is punctured. Set regulator at 695 kPa (100 psi). Open the inlet valve by turning counter-clockwise one and a half turns.

6. After 30 min, close the valve by turning clockwise.

7. Record the volume of the filtrate.

8. Disassemble the mud cell; remove the filter paper with minimum disturbance to the filter cake; gently wash excess mud off the filter cake; measure filter cake thickness.

API specifications allow a maximum 14 mL of filtrate for drilling mud material.

TEST RESULTS

Three bentonite samples of different grades were used in evaluating the operation of the equipment for testing. Sample A is a high grade sodium bentonite; Sample B is a medium grade sodium betonite; and Sample C is a calcium bentonite. Test results are given in Table 1. The results indicate that, as expected, only Sample A, a high-grade sodium bentonite, meets all the API specification requirements for drilling fluid and also gives excellent qualities in colloidal content, swelling and gel strength. Sample B meets the requirements for moisture, residue and filtrate, and Sample C meets none of the specifications.

ACKNOWLEDGEMENTS

The authors thank Willian R. Barnes Co. for providing two of the bentonite samples used.

REFERENCES

1. Ross J.S. "Bentonite in Canada"; Mines Branch Monograph 873; CANMET, Energy, Mines and Resources Canada; 1964.

2. Anon "API specification for oil-well drilling-fluid materials"; API standard 13A; American Petroleum Institute; 1964.

Table 1. Test Results

Sample	Moisture %	Residue (sand content) %	Colloidal cont.%	Swelling mL	Plastic Vis. CP	App. Vis. CP	Yield Pt. lb/100 ft	Gel Strength 100/ft^2		Filtrate mL	Filter cake thickness mm
								Initial	10 min.		
A	3.4	1.8	99.5	40	8	26	36	30	52	11.2	1.6
B	11.3	1.2	77.3	18	4	7.5	7	1	18	11.4	0.8
C	13.3	7.4	17.0	5	1	1.5	1	0.5	2	59	0.6
API spec.	max. 12	max. 2.5			min. 8.0					max. 14	